REPORT TO THE ALASKA BOARD OF FISHERIES ON

THE FEASIBILITY OF USING SCALE PATTERN ANALYSIS

TO SEPARATE MAJOR EAST SIDE BRISTOL BAY SOCKEYE SALMON STOCKS

FROM MAJOR NORTHERN ALASKA PENINSULA SOCKEYE SALMON STOCKS

IN 1990 EAST SIDE BRISTOL BAY FISHERIES

By

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and

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
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INTRODUCTION

Stock composition of sockeye salmon commercial catches from the Three Hills and Ilnik Sections of the Northern Alaska Peninsula Management Area was examined by Geiger (1989) and Swanton and Murphy (*in press*) using scale pattern analysis. Both studies showed that sockeye salmon bound for spawning systems on the east side of the Bristol Bay Management Area comprised a large proportion of the catch within the Three Hills and Ilnik Sections during all four years examined 1987–1990. While Geiger (1989) limited his study to the inclusion of Ugashik River, Bristol Bay, sockeye salmon stocks within Northern Alaska Peninsula catches, Swanton and Murphy (*in press*) also included Kvichak, Naknek, and Egegik River, Bristol Bay, sockeye salmon stocks within their models.

The present study attempted to use scale pattern analysis to identify Northern Alaska peninsula stocks within east side Bristol Bay fishing districts. While Geiger (1989) also explored the possibility of identifying Northern Alaska Peninsula stocks within Bristol Bay catches, he limited his study to the Ugashik District. This study included the four most abundant east side Bristol Bay stocks (Kvichak, Naknek, Egegik, and Ugashik) as well as major Northern Alaska Peninsula stocks within classification models and examined catches from all three east side Bristol Bay fishing districts. Results of the two studies were similar: Northern Alaska Peninsula stocks did not occur in great enough numbers in Bristol Bay Management Area catches to be detected using scale pattern analysis.

METHODS

Age-2.2 Model Construction

Escapement samples from major east side Bristol Bay systems (Kvichak, Naknek, Egegik, and Ugashik Rivers) and major Northern Alaska Peninsula systems (Bear and Nelson Rivers) provided scales of known origin which were digitized and used to build the six-way stock identification model (Figure 1). Scale samples from each escapement were weighted by run strength through time. Escapement samples collected in 1990 were used to classify 1990 catches. Due to time restraints, only age-2.2 scales were included in the analysis. Sockeye salmon aged 2.2 represented 39.6% of the east side Bristol Bay harvest. A complete description of methods used to construct stock identification models in Bristol Bay can be found in Cross and Stratton (1991).

Age-2.2 Classification

Commercial catch samples from Naknek-Kvichak, Egegik, and Ugashik Districts provided scales of unknown origin which were classified with the stock identification model to estimate contribution by river to the age-2.2 harvests. Each catch sample was initially classified with a model that included all six rivers (Kvichak, Naknek, Egegik, Ugashik, Bear, and Nelson Rivers). If the contribution of one or more rivers was estimated to be zero, the catch sample was reclassified using a model which did not include those rivers. Stock estimates were adjusted for misclassification error using the procedure of Cook and Lord (1978).

RESULTS

Catch and Escapement

In 1990, 29,357,846 sockeye salmon were harvested in east side Bristol Bay Districts (Table 1). Age-2.2 sockeye salmon comprised 39.6% of the total harvest. Of the 17,126,625 sockeye salmon caught in Naknek-Kvichak District, 45.0% were age-2.2. Sockeye catches in Egegik District were 10,086,953 of which 41.6% were age-2.3 and 32.2% were age-2.2. Of the 2,144,268 sockeye caught in Ugashik District, 31.3% were age-2.2.

Sockeye salmon escapements into major east side Bristol Bay rivers in 1990 were: 6,970,020 into Kvichak River, of which 87.6% were age-2.2; 2,092,578 into Naknek River, of which 27.6% were age-2.2; 2,191,362 into Egegik River, of which 42.0% were age-2.2; and 730,038 into Ugashik River, of which 37.8% were age-2.2 (Table 2). Major Northern Alaska Peninsula escapements were: 546,800 into Bear River, of which 67.1% were age-2.2; and 240,700 into Nelson River, of which 33.2% were age-2.2.

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Age-2.2 Classification Model

The mean proportion of age-2.2 sockeye salmon correctly classified by the six way model was 0.747 (Table 3). Classification accuracy was highest for Northern Alaska Peninsula stocks (Bear River = 0.807; Nelson River = 0.845). Northern Alaska Peninsula stocks misclassified more to east side Bristol Bay stocks than to each other. Bear River tended to misclassify to Naknek River, while Nelson River misclassified to Kvichak and Naknek Rivers. Classification accuracies of Kvichak (0.786), Egegik (0.745), and Ugashik (0.737) Rivers were similar to each other. Naknek River classification accuracy (0.564) was the lowest of all stocks. Although east side Bristol Bay stocks tended to misclassify more to each other than to Northern Alaska Peninsula stocks, 8.0% of Kvichak River samples misclassified to Nelson River while 9.7% of Naknek River samples classified to Bear and Nelson Rivers.

Classification of Age-2.2 Catches

East side Bristol Bay stocks comprised 98.6% (7,200,461) of the age-2.2 sockeye salmon caught in Naknek-Kvichak District from 20 June through 16 July (Table 4). Kvichak and Naknek stocks contributed 96.0% of the total. Only 1.4% (97,256) of the age-2.2 sockeye salmon catch was classified to Northern Alaska Peninsula Rivers (41,005 to Bear and 56,251 to Nelson).

Of the 3,095,891 age-2.2 sockeye salmon caught in Egegik District from 21 June to 18 July, 98.5% (3,047,998) were classified to east side Bristol Bay Rivers (Table 5). The main contributors were Egegik (56.7%) and Kvichak (36.4%) Rivers. Only 1.5% (47,893) of the age-2.2 sockeye salmon catch was classified to Northern Alaska Peninsula Rivers. Most of these (43,928) were attributed to Nelson River.

Of the 537,488 sockeye salmon caught in Ugashik District from 22 June to 17 July 99.5% were classified to east side Bristol Bay Rivers (Table 6). The main contributor was Ugashik River (83.7%). Only 0.5% (2,755) of the age-2.2 sockeye salmon catch was classified to Northern Alaska Peninsula Rivers. Almost all of these (2,746) were attributed to Nelson River.

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DISCUSSION

The six-way age-2.2 stock identification model constructed from scale patterns of major east side Bristol Bay and Northern Alaska Peninsula sockeye salmon was very accurate. Consequently, it appeared that scale pattern analysis might be used to identify Northern Alaska Peninsula sockeye salmon within east side Bristol Bay commercial catch samples. However, the following problems must be considered when interpreting results:

(1) Scale pattern analysis classifies scales from catch samples to stocks included in the model. If a stock is present in the catch sample but not represented in the model, it will be classified to the stock in the model which it most closely resembles. Several Bristol Bay stocks were not included in the 1990 model (Alagnak [Branch], Wood, Nushagak, Igushik, and Togiak). These stocks had a combined run of 238,895 age-2.2 sockeye salmon in 1990 (Table 7). The 1990 estimate of age-2.2 Northern Alaska Peninsula sockeye salmon caught in east side Bristol Bay s was 147,904.

(2) The age-2.2 stock identification model was fairly accurate, however, misclassification among rivers did occur. Kvichak River misclassified to Nelson River while Naknek River misclassified to Bear and Nelson River. When east side Bristol Bay commercial catches were classified with the model, almost all samples (about 99%) classified to the east side Bristol Bay rivers included in the model. Very few samples (about 1%) were classified to the Northern Alaska Peninsula rivers included in the model. Over 29,000,000 sockeye salmon were caught in east side Bristol Bay fishing districts in 1990. A 1% misclassification error would result in a 290,000 fish contribution error.

(3) Estimates of Northern Alaska Peninsula age-2.2 sockeye salmon in east side Bristol Bay districts were directly related to the abundance of Naknek and Kvichak River stocks within those districts. Most samples classified to Northern Alaska Peninsula stocks in Naknek-Kvichak and Egegik districts. These districts had a high abundance of Kvichak and Naknek stocks. Few samples were classified to Northern Alaska Peninsula stocks in Ugashik District. This district had a low abundance of Kvichak and Naknek stocks. Also, most of the sockeye salmon classified to Northern Alaska Peninsula rivers were identified as Nelson River.

(4) Ugashik District is the closest east side Bristol Bay district to Northern Alaska Peninsula rivers. The 1990 Ugashik district sockeye salmon harvest of 2.1 million was the seventh largest catch in the history of the fishery. Yet, results show few Ugashik District sockeye salmon classified to Northern Alaska Peninsula rivers. The stock identification model would have had the best resolution in Ugashik District as most of the catch were Ugashik stocks. Kvichak and Naknek stocks, which misclassify to Nelson and Bear, were present in very low numbers. Only 0.5% of the catch classified to Northern Alaska Peninsula stocks, basically all to Nelson River.

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CONCLUSIONS

Although the stock identification model developed was fairly accurate, it could not be used to estimate the occurrence of Northern Alaska Peninsula sockeye salmon in east side Bristol Bay. About 1% of the east side Bristol Bay age-2.2 harvest was classified to Northern Alaska Peninsula rivers. This level of occurrence is beyond the resolution possible with the model.

Because of relative run size differences between Bristol Bay and Northern Alaska Peninsula sockeye salmon stocks, it will always be difficult to accurately determine whether Northern Alaska Peninsula sockeye salmon are caught in Bristol Bay districts. However, it may be possible to determine if Nelson River fish are caught in Bristol Bay by screening the Bristol Bay commercial catch for the brain parasite *Myxobolus neurobius*. Studies conducted by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service have documented the presence of this brain parasite in Nelson River sockeye salmon, and its absence in Bristol Bay stocks. This might provide a natural marker which could be used to identify Nelson River sockeye salmon.

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TABLES AND FIGURE

Table 1. Age composition of sockeye salmon commercial catches, east side Bristol Bay, 1990.

District		1.2	1.3	2.2	2.3	Other[a]	Total
				Age Groups			
Naknek–Kvichak	#	1,985,272	3,867,918	7,702,820	3,491,358	79,257	17,126,625
	%	11.6	22.6	45.0	20.4	0.4	100.0
Egegik	#	1,203,574	1,215,720	3,248,740	4,192,760	226,159	10,086,953
	%	11.9	12.1	32.2	41.6	2.2	100.0
Ugashik	#	318,815	516,656	673,465	590,690	44,642	2,144,268
	%	14.8	24.2	31.3	27.7	2.0	100.0
Total	#	3,507,661	5,600,294	11,625,025	8,274,808	350,058	29,357,846
	%	12.0	19.1	39.6	28.2	1.1	100.0

[a] Other includes age groups 0.2, 0.3, 2.1, 1.4, 3.2, 2.4, and 3.3

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Table 2. Age composition of selected sockeye salmon escapements, east side
Bristol Bay and Northern Alaska Peninsula Rivers, 1990.

Escapement		Age Groups					Total
		1.2	1.3	2.2	2.3	Other[a]	
Kvichak	#	211,062	234,020	6,101,908	397,935	25,095	6,970,020
	%	3.0	3.4	87.6	5.7	0.3	100.0
Naknek	#	587,225	639,524	577,631	281,464	6,734	2,092,578
	%	28.1	30.6	27.6	13.4	0.3	100.0
Egegik	#	553,754	114,787	918,871	548,009	55,941	2,191,362
	%	25.3	5.2	42.0	25.0	2.5	100.0
Ugashik	#	161,531	174,878	276,080	93,626	23,923	730,038
	%	22.1	23.9	37.8	12.9	3.3	100.0
East Side	#	1,513,572	1,163,209	7,874,490	1,321,034	111,693	11,983,998
Total	%	12.6	9.7	65.8	11.0	0.9	100.0
Bear	#	54,200	10,872	366,762	90,033	24,933	546,800
	%	9.9	2.0	67.1	16.5	4.5	100.0
Nelson	#	7,821	37,527	79,852	107,282	8,218	240,700
	%	3.2	15.6	33.2	44.6	3.4	100.0
North Pen.	#	62,021	48,399	446,614	197,315	33,151	787,500
Total	%	7.9	6.1	56.7	25.1	4.2	100.0

[a] Other includes age groups 0.2, 1.1, 0.3, 2.1, 0.4, 1.4, 3.2, 2.4, and 3.3

Table 3. Stock identification model developed from age-2.2 sockeye salmon sampled from Kvichak, Naknek, Egegik, Ugashik, Bear and Nelson Rivers, 1990.

Actual Group Of Origin	Sample Size	Classified Group of Origin					
		Kvichak	Naknek	Egegik	Ugashik	Bear	Nelson
Kvichak	187	0.786	0.064	0.000	0.070	0.000	0.080
Naknek	195	0.077	0.564	0.133	0.128	0.082	0.015
Egegik	200	0.010	0.105	0.745	0.085	0.055	0.000
Ugashik	198	0.066	0.121	0.035	0.737	0.035	0.005
Bear	150	0.000	0.093	0.040	0.053	0.807	0.007
Nelson	148	0.068	0.061	0.014	0.007	0.007	0.845

Mean proportion correctly classified = 0.747

Table 4. Classification of age–2.2 sockeye salmon catch, Naknek–Kvichak District, 1990.

Sample Date		Classified River of Origin						Total[a]
		Kvichak	Naknek	Egegik	Ugashik	Bear	Nelson	
6/20–6/22	#	38,800	0	6,056	0	0	0	44,856
	%	86.5	0.0	13.5	0.0	0.0	0.0	100.0
6/28–6/29	#	332,690	74,855	0	0	0	8,318	415,863
	%	80.0	18.0	0.0	0.0	0.0	2.0	100.0
6/30[b]	#	291,592	98,237	0	0	0	0	389,829
	%	74.8	25.2	0.0	0.0	0.0	0.0	100.0
7/01–7/03	#	1,281,343	188,345	13,347	0	0	0	1,483,035
	%	86.4	12.7	0.9	0.0	0.0	0.0	100.0
7/04–7/05	#	991,802	176,657	16,404	56,783	0	20,189	1,261,835
	%	78.6	14.0	1.3	4.5	0.0	1.6	100.0
7/06–7/09	#	1,510,878	134,838	50,132	0	32,845	0	1,728,693
	%	87.4	7.8	2.9	0.0	1.9	0.0	100.0
7/10–7/11	#	638,113	126,835	17,331	5,515	0	0	787,794
	%	81.0	16.1	2.2	0.7	0.0	0.0	100.0
7/12–7/14	#	611,357	166,451	0	0	0	0	777,808
	%	78.6	21.4	0.0	0.0	0.0	0.0	100.0
7/15–7/16	#	284,379	65,281	3,672	18,768	8,160	27,744	408,004
	%	69.7	16.0	0.9	4.6	2.0	6.8	100.0
TOTAL	#	5,980,954	1,031,499	106,942	81,066	41,005	56,251	7,297,717
	%	81.9	14.1	1.5	1.1	0.6	0.8	100.0

Bristol Bay # 7,200,461
% 98.6

North Peninsula # 97,256
% 1.4

[a] Total does not include sockeye salmon caught prior to 20 June and after 16 July that were not sampled, and were assumed to be of Bristol Bay origin.

[b] Naknek section only opening

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Table 5. Classification of age-2.2 sockeye salmon catch, Egegik District, 1990.

| Sample Date | | Classified River of Origin | | | | | | Total[a] |
		Kvichak	Naknek	Egegik	Ugashik	Bear	Nelson	
6/21	#	12,979	4,110	9,290	282	0	1,492	28,153
	%	46.1	14.6	33.0	1.0	0.0	5.3	100.0
6/22–6/30	#	86,530	5,387	76,429	0	0	0	168,346
	%	51.4	3.2	45.4	0.0	0.0	0.0	100.0
7/01–7/02	#	182,467	0	244,856	0	0	0	427,323
	%	42.7	0.0	57.3	0.0	0.0	0.0	100.0
7/03–7/04	#	108,886	2,577	207,786	2,899	0	0	322,149
	%	33.8	0.8	64.5	0.9	0.0	0.0	100.0
7/05–7/06	#	218,528	0	377,568	0	0	10,926	607,022
	%	36.0	0.0	62.2	0.0	0.0	1.8	100.0
7/07–7/08	#	181,708	0	208,182	0	401	10,830	401,122
	%	45.3	0.0	51.9	0.0	0.1	2.7	100.0
7/10	#	114,064	0	219,435	4,521	0	9,737	347,757
	%	32.8	0.0	63.1	1.3	0.0	2.8	100.0
7/12–7/13	#	96,506	0	139,550	31,803	3,564	2,742	274,165
	%	35.2	0.0	50.9	11.6	1.3	1.0	100.0
7/14–7/15	#	85,535	28,852	121,025	19,916	0	0	255,328
	%	33.5	11.3	47.4	7.8	0.0	0.0	100.0
7/16–7/18	#	39,679	0	148,928	67,719	0	8,200	264,526
	%	15.0	0.0	56.3	25.6	0.0	3.1	100.0
TOTAL	#	1,126,882	40,927	1,753,050	127,139	3,965	43,928	3,095,891
	%	36.4	1.3	56.7	4.1	0.1	1.4	100.0

Bristol Bay # 3,047,998
% 98.5

North Peninsula # 47,893
% 1.5

[a] Total does not include sockeye salmon caught prior to 21 June and after 18 July that were not sampled, and were assumed to be of Bristol Bay origin.

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Table 6. Classification of age–2.2 sockeye salmon catch, Ugashik District, 1990.

| Sample Date | | Classified River of Origin | | | | | | Total[a] |
		Kvichak	Naknek	Egegik	Ugashik	Bear	Nelson	
6/22	#	726	39	1,089	434	9	0	2,298
	%	31.6	1.7	47.4	18.9	0.4	0.0	100.0
6/26–7/04	#	5,240	0	1,695	31,594	0	0	38,529
	%	13.6	0.0	4.4	82.0	0.0	0.0	100.0
7/06–7/09	#	12,848	0	24,918	156,902	0	0	194,668
	%	6.6	0.0	12.8	80.6	0.0	0.0	100.0
7/10–7/12	#	7,338	0	7,939	105,014	0	0	120,291
	%	6.1	0.0	6.6	87.3	0.0	0.0	100.0
7/13–7/15	#	3,560	0	12,509	82,887	0	2,746	101,702
	%	3.5	0.0	12.3	81.5	0.0	2.7	100.0
7/16–7/17	#	6,720	0	0	73,280	0	0	80,000
	%	8.4	0.0	0.0	91.6	0.0	0.0	100.0
Total	#	36,432	39	48,151	450,111	9	2,746	537,488
	%	6.8	0.0	9.0	83.7	0.0	0.5	100.0

Bristol Bay # 534,733
           %   99.5

North Peninsula # 2,755
              %   0.5

[a] Total does not include sockeye salmon caught prior to 22 June and after 17 July that were not sampled, and were assumed to be of Bristol Bay origin.

Table 7. Estimated inshore sockeye salmon runs to Bristol Bay Rivers not included in the 1990 analysis.

Run		1.2	1.3	2.2	2.3	Other[a]	Total
Branch	#	329,442	108,992	89,435	22,149	321	550,339
River	%	59.8	19.8	16.3	4.0	0.1	100.0
Wood	#	1,155,502	1,369,568	28,798	22,056	66,370	2,642,294
River	%	43.7	51.9	1.1	0.8	2.5	100.0
Nushagak	#	112,201	602,514	6,218	6,169	1,049,196	1,776,298
River	%	6.3	33.9	0.4	0.3	59.1	100.0
Igushik	#	227,196	900,848	83,746	34,979	19,463	1,266,232
River	%	17.9	71.2	6.6	2.8	1.5	100.0
Togiak	#	67,573	191,724	30,698	14,160	22,107	326,262
River	%	20.7	58.8	9.4	4.3	6.8	100.0
Total	#	1,891,914	3,173,646	238,895	99,513	1,157,457	6,561,425
	%	28.8	48.5	3.6	1.5	17.6	100.0

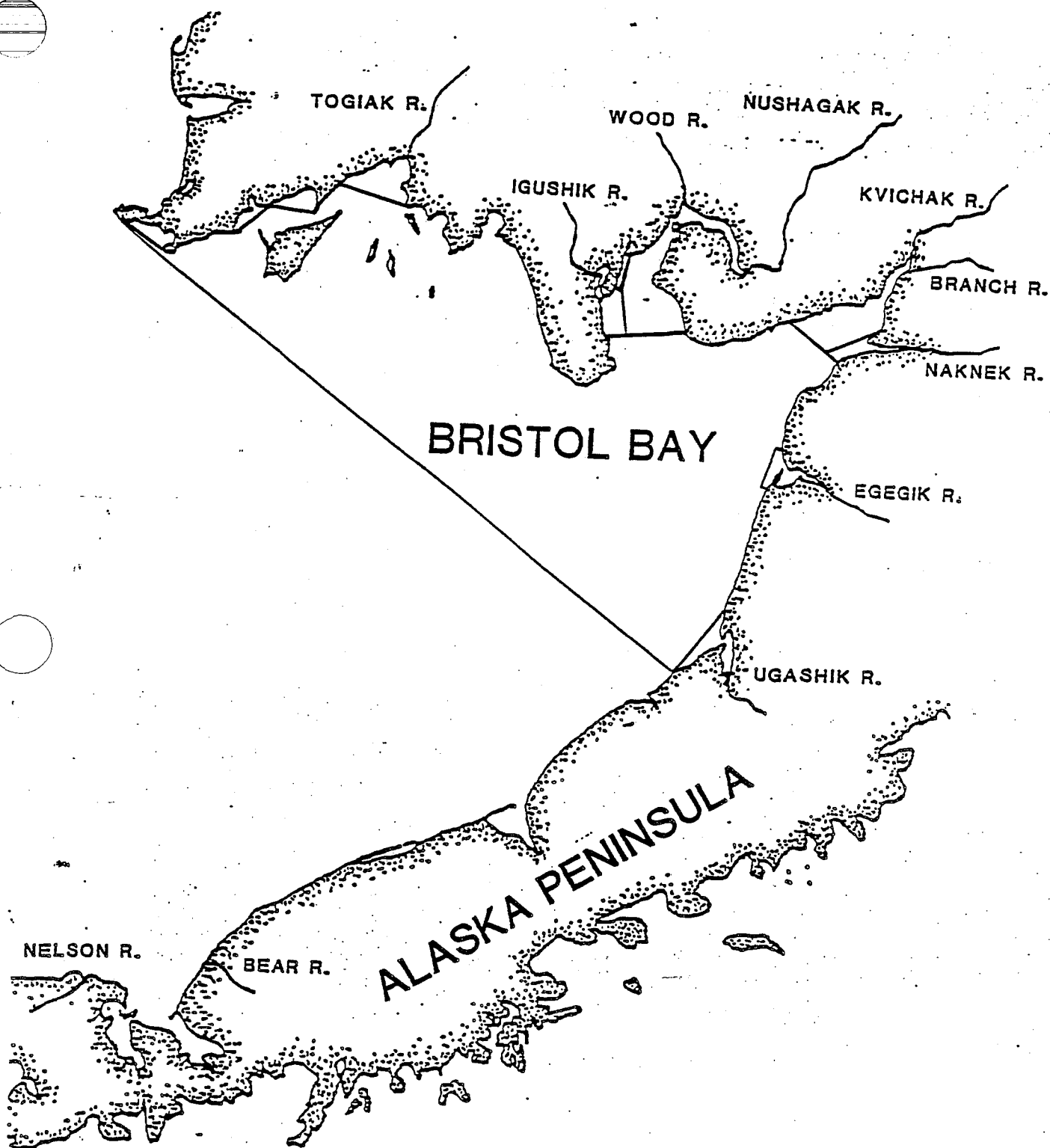[a] Other includes age groups 0.2, 0.3, 0.4, 1.4, 3.2, 2.4, and 3.3

Figure 1.   Map of Bristol Bay and Northern Alaska Peninsula showing fishing districts and rivers.

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